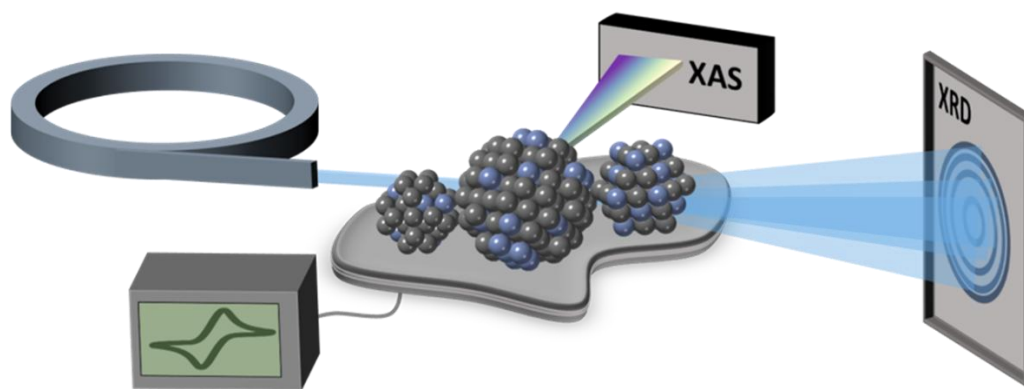


Watching nanoparticles in action: Characterizing electrocatalysts with synchrotron X-rays

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Electrocatalysis plays a major role in energy conversion technologies such as electrolyzers and fuel cells. Small nanoparticles, typically less than 10 nm in size, provide a high surface-to-bulk-atom ratio which is crucial for efficient utilization of the catalyst material, often based on scarce precious metals like Pt^[1] and Ir.^[2] However, these small nanoparticles suffer frequently from instability in electrochemical environments, and the underlying degradation mechanisms and structural rearrangements are, so far, not fully understood.^[3] In this context, synchrotron X-ray techniques are valuable tools for unraveling the catalyst's structural changes during operation. *In-situ* and *operando* experiments enable us to monitor the evolution of atomic structures. With small-angle X-ray scattering (SAXS), changes in size and morphology can be tracked,^[1] while X-ray total scattering with PDF analysis provides insights into the atomic structure.^[4] This can provide valuable information on the mechanisms that dominate catalyst degradation and help devise new strategies for stability optimization. I will focus on the strengths and limitations of the different *operando* scattering techniques, SAXS, XRD, and X-ray total scattering, and how they can be combined with X-ray absorption spectroscopy (XAS). This integration offers a complete picture of the catalyst structure at applied potentials, which is fundamental for establishing structure-property relations.



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